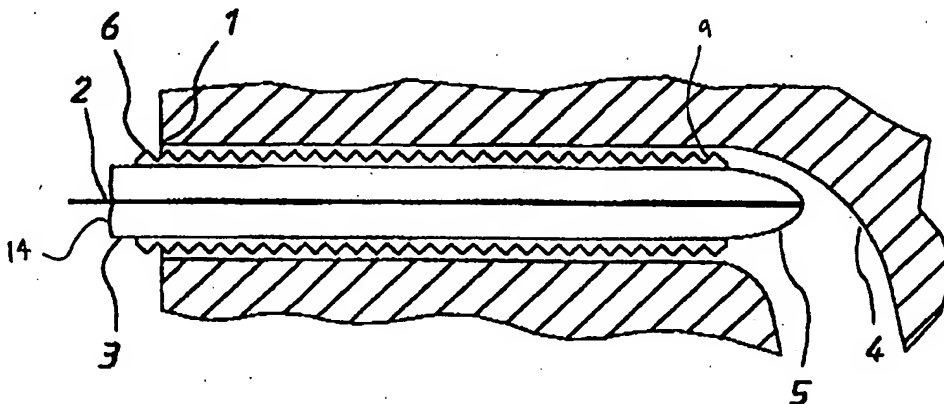




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(21) International Application Number: PCT/AU98/00388 (22) International Filing Date: 26 May 1998 (26.05.98) (30) Priority Data: PO 6954 26 May 1997 (26.05.97) AU (71)(72) Applicant and Inventor: BARRY, Kevin, Francis, Patrick, Jr. [AU/AU]; 25A Benning Avenue, Turrumurra, NSW 2074 (AU). (74) Agent: BALDWIN SHELSTON WATERS; 60 Margaret Street, Sydney, NSW 2000 (AU).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: METHOD OF REHABILITATING AN EXISTING PIPELINE



(57) Abstract

The method is related to the rehabilitation of an existing pipeline in-situ, where the pipeline has a first end (1) and a second end (4), the method including the following steps: (a) forming a tubular liner (6) of a generally absorbent material; (b) feeding at least one expandable bladder (3) into the liner (6), the bladder having an open end (14) and a sealed end (5); (c) impregnating the liner (6) with a cold curable resin; (d) coating an external surface of the liner (6) and/or the internal surface of the pipeline to be rehabilitated with a water resistance adhesive coating; (e) feeding the liner into the first end (1) of the pipeline together with its associated bladder (3); (f) inserting a rod (2) into the bladder (3) to engage the sealed end (5); (g) forcing the liner (6) and the associated bladder (3) toward the second end (4) of the pipeline from the first end (1) such that the open end (14) and the sealed end (5) of the bladder (3) are adjacent the first and second ends (1, 4) respectively; (h) inflating the bladder (3) from the open end (14) with a gaseous fluid to force the liner (6) against the internal wall of the pipeline; and (i) maintaining the inflation until the resin impregnated liner has cured.

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TITLE: METHOD OF REHABILITATING AN EXISTING PIPELINE**Technical Field**

The present invention relates to a method of rehabilitating an existing pipeline in-situ.

5 Background Art

A method of rehabilitating an existing pipeline is disclosed in WO97/08487, the contents of which are hereby incorporated in their entirety by way of cross reference.

Disclosure of the Invention

- According to a first aspect of the invention there is provided a method for
- 10 rehabilitating an existing pipeline in-situ, said pipeline having a first end and second end, said method including the following steps:
- a) forming a tubular liner of a generally absorbent material;
 - b) feeding at least one expandable bladder into said liner, said bladder having an open end and a sealed end;
 - 15 c) impregnating said liner with a cold curable resin;
 - d) feeding said liner into the first end of the pipeline together with its associated bladder;
 - e) inserting a rod into the bladder to engage the sealed end;
 - f) forcing said liner and the associated bladder toward the second end of the
 - 20 pipeline by pushing a rod into the pipeline from the first end such that the open end and the sealed end of the bladder are respectively disposed at or adjacent to the first and second end respectively;

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g) inflating said bladder from said open end with a gaseous fluid to force the liner against the internal wall of said pipeline; and

h) maintaining said inflation until the resin impregnated liner has cured.

Preferably, the method also includes the step of coating an external surface of
5 said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating.

According to a second aspect of the invention there is provided a method for rehabilitating an existing pipeline in-situ, said pipeline having a first end and second end, said method including the following steps:

- 10 a) forming a tubular liner of a generally absorbent material;
- b) feeding at least one expandable bladder into said liner, said bladder having an open end and a sealed end;
- c) impregnating said liner with a cold curable resin;
- d) feeding said liner into the first end of the pipeline together with its
15 associated bladder;
- e) inserting a rod between the liner and the internal surface of the pipeline so as to engage a slit disposed adjacent an end of the liner;
- f) forcing said liner and the associated bladder toward the second end of the pipeline by pushing a rod into the pipeline from the first end such that the open
20 end and the sealed end of the bladder are respectively disposed at or adjacent to the first and second end respectively;
- g) inflating said bladder from said open end with a gaseous fluid to force the liner against the internal wall of said pipeline; and

- h) maintaining said inflation until the resin impregnated liner has cured.

Preferably, the method also includes the step of coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating.

5 According to a third aspect of the invention there is provided a method for rehabilitating an existing pipeline in-situ, said pipeline having a first end and a second end, said method including the following steps:

- a) forming a tubular liner of a generally absorbent material;
- b) feeding at least one expandable bladder into said liner, said bladder having
10 an open end and a sealed end;
- c) impregnating said liner with a cold curable resin;
- d) threading a cord having a third end and a fourth end through said pipeline such that the fourth end extends from the second end of the pipeline;
- e) attaching the third end of said cord to said liner and/or bladder;
- 15 f) drawing said fourth end through said second end for progressing said liner through the pipeline together with its associated bladder such that the open end and the sealed end of the bladder are respectively disposed at or adjacent to the first and second ends respectively;
- g) inflating said bladder from said open end with a gaseous fluid to force the
20 liner against the internal wall of said pipeline; and
- h) maintaining said inflation until the resin impregnated liner has cured.

Preferably, the method also includes the step of coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating.

According to a fourth aspect of the invention there is provided a method for
5 rehabilitating an existing pipeline in-situ, said pipeline including a main line to be rehabilitated and a secondary line branching from said main line, the method including the following steps:

- a) forming a tubular liner of a generally absorbent material;
- b) feeding at least one expandable bladder into said liner;
- 10 c) determining a junction position along the main line at which said secondary line branches from said main line;
- d) cutting a hole in said liner at a position corresponding to the junction position;
- e) impregnating said liner with a cold curable resin;
- 15 f) feeding said liner into the pipeline together with its associated bladder such that said hole is aligned with said secondary line;
- g) inflating said bladder with a gaseous fluid to force the liner against the internal wall of said pipeline; and
- h) maintaining said inflation until the resin impregnated liner has cured.

20 Preferably, the method also includes the step of coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating.

According to a fifth aspect of the invention there is provided a method for rehabilitating an existing pipeline in-situ including the following steps:

- a) forming a tubular liner of a generally absorbent material;
- b) feeding at least one expandable bladder into said liner;
- 5 c) feeding at least one cable or conduit between said bladder and liner;
- d) impregnating said liner with a cold curable resin;
- e) feeding said liner into the pipeline together with its associated bladder;
- f) inflating said bladder with a gaseous fluid to force the liner against the internal wall of said pipeline; and
- 10 g) maintaining said inflation until the resin impregnated liner has cured, thereby encasing said cable or conduit within said resin.

Preferably, the method also includes the step of coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating.

15 According to another aspect of the invention there is provided a method for rehabilitating an existing pipeline in-situ including the following steps:

- a) forming a tubular liner of a generally absorbent material;
- b) feeding at least one expandable bladder into said liner;
- c) impregnating said liner with a cold curable resin;
- 20 d) coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating;
- e) feeding said liner into the pipeline together with its associated bladder;
- f) feeding at least one cable or conduit between said liner and said pipeline;

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g) inflating said bladder with a gaseous fluid to force the liner against the internal wall of said pipeline; and

h) maintaining said inflation until the resin impregnated liner has cured.

Preferably, the method also includes the step of coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating.

Brief Description of the Drawings

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

10 Figure 1 is a longitudinal sectional view of a pipeline being rehabilitated in accordance with the first aspect of the invention;

Figure 2 is a longitudinal sectional view of a pipeline being rehabilitated in accordance with the second aspect of the invention;

15 Figure 3 is a longitudinal sectional view of a pipeline being rehabilitated in accordance with a third aspect of the invention;

Figure 4 is a longitudinal section view of a pipeline being rehabilitated in accordance with the fourth aspect of the invention;

Figure 5 is a transverse sectional view taken through line 5-5 of figure 4;

20 Figure 6 is a longitudinal sectional view of a pipeline being rehabilitated in accordance with the fifth aspect of the invention;

Figure 7 is a transverse sectional view taken through line 7-7 of figure 6;

Figures 8a and 8b are transverse cross sectional views of a pipeline being rehabilitated in accordance with another aspect of the invention.

Modes for Carrying out the Invention

A method according to a preferred embodiment of the invention will now be described with reference to figure 1. More particularly, the method is related to the rehabilitation of an existing pipeline in-situ, said pipeline having a first end 1 and a

5 second end 4, said method including the following steps:

- a) forming a tubular liner 6 of a generally absorbent material;
- b) feeding at least one expandable bladder 3 into said liner 6, the bladder having an open end 14 and a sealed end 5;
- c) impregnating said liner 6 with a cold curable resin;
- 10 d) coating an external surface of said liner 6 and/or the internal surface of the pipeline to be rehabilitated with a water resistance adhesive coating;
- e) feeding said liner into the first end 1 of the pipeline together with its associated bladder 3;
- f) inserting a rod 2 into the bladder 3 to engage the sealed end 5;
- 15 g) forcing the liner 6 and the associated bladder 3 toward the second end 4 of the pipeline from the first end 1 such that the open end 14 and the sealed end 5 of the bladder 3 are adjacent the first and second ends 1 and 4 respectively;
- h) inflating said bladder 3 from said open end 14 with a gaseous fluid to force the liner 6 against the internal wall of the pipeline; and
- 20 i) maintaining said inflation until the resin impregnated liner has cured.

In an alternative embodiment, rod 2 is engaged with the slit 9 before the liner 6 is fed into the pipeline. Optionally, the liner 6 may be folded longitudinally into halves, as shown in figure 8 and the rod 2 may be affixed to the liner 6 by means of

adhesive tape 20 positioned so as to span the gap between the two halves of the liner. The liner 6 is then fed into the pipeline by means of pushing the rod 2. Once the bladder 3 is subsequently inflated, the folded liner 6 will expand, thereby breaking or dislodging the tape and allowing the rod 2 to be removed from the pipeline before the
5 resin cures.

The above described aspects of the invention advantageously allow for rehabilitation of a pipeline having a first end 1 which is generally accessible and a second end 4 which is generally inaccessible.

Figure 2 depicts a method for rehabilitating an existing pipeline in-situ, said
10 pipeline having a first end 1 which is generally inaccessible and a second end 4 to which only limited access is available, for example via a secondary pipeline 16 of smaller diameter than that of the pipeline to be rehabilitated. The method is similar to that described above except a rope 7 (or alternatively a cable or the like) is utilised to force the liner 6 and bladder 3 toward the second end 4 rather than the rod 2.
15 According to this method, the rope 7 is threaded through the pipeline and attached to the distal end of the liner 6 and/or the bladder 3. The liner 6 is then fed into the first end 1 of the pipeline together with its associated bladder 3 such that the sealed end 5 of the bladder faces the second end 4 of the pipeline. The liner 6 and associated bladder 3 is then fed through the pipeline by means of pulling on the rope 7 from the
20 second end 4.

Although rope 7 is shown attached to bladder 3, in other embodiments it is attached, and preferably removably, to liner 6.

Figure 3 shows a method for rehabilitating existing pipelines in-situ which is suited to pipelines having junctions. The prior art method for dealing with this situation was to firstly allow a continuous resin impregnated liner to cure inside the pipeline. A remote control lateral or a branch cutter was then driven up the pipeline to the junction and a hole was cut out to allow fluid to flow through the branch line into the main line. Alternatively, the junction was excavated and cut by hand.

The method shown in figure 3 significantly improves upon the prior art procedure. The pipeline includes a mainline 8 to be rehabilitated and a secondary line 10 branching from the main line 8. The method includes the following steps:

- 10 a) forming a tubular liner 6 of a generally absorbent material;
- b) feeding at least one expandable bladder 3 into said liner 6;
- c) determining a position 9 along the main line 8 at which said secondary line 10 branches from said main line 8;
- d) cutting a hole 17 in the liner 6 at a position corresponding the position at
15 which said secondary branches from said main line;
- e) impregnating said liner 6 with a cold curable resin;
- f) coating an external surface of said liner 6 and/or the internal surface of the main pipeline to be rehabilitated 8 with a water resistant adhesive coating;
- g) feeding said liner 6 into the pipeline together with its associated bladder 3
20 such that said hole 17 is aligned with said secondary pipeline 10;
- h) inflating said bladder 3 with a gaseous fluid to force the liner 6 against the internal wall of said main pipeline 8; and
- i) maintaining said inflation until the resin impregnated liner has cured.

This method advantageously avoids the need to take further steps after curing of the resin to cut a hole at the junction position.

Figures 4 to 7 show methods that may be employed if it is desired to install a cable, conduit or the like along the rehabilitated pipeline. This may be particularly
5 advantageous, for example, in regions where it is desired to connect additional telecommunications lines, such as optical cables, without causing additional overhead wiring.

Figures 4 and 5 show a method for rehabilitating an existing pipeline in-situ wherein a cable or conduit 11 is fed between the bladder 3 and the liner 6. The
10 pipeline is then rehabilitated in the standard manner and inflation of the bladder 3 causes the cable or conduit to "sink" into the resin impregnated liner. Once the resin impregnated liner 6 has cured, the cable or conduit 11 is encased within the resin. This ensures that the cable or conduit 11 does not obstruct flow along the pipeliner and therefore does not contribute to blockages. The cable or conduit 11 is preferably
15 positioned along the length of the pipe-line so as not to obstruct any junctions that may branch from the main line.

Figures 6 and 7 depict a method for rehabilitating an existing pipeline in-situ wherein a cable or conduit 11 is fed between the liner 6 and the internal surface 12
of the pipeline. Once the liner 6 has cured, the cable or conduit 11 is at least partially
20 encased within resin which exudes from the liner 6 and within the water resistant adhesive which is coated onto the external surface of the liner 6.

Although the invention has been described with reference to specific examples, it would be appreciated by those skilled in the art that the invention may be embodied

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in many other forms. For example, it will be appreciated that some of the steps of the methods disclosed in this specification may be taken in a different order to that in which they have been listed.

CLAIMS:

1. A method for rehabilitating an existing pipeline in-situ, said pipeline having a first end and second end, said method including the following steps:
 - a) forming a tubular liner of a generally absorbent material;
 - 5 b) feeding at least one expandable bladder into said liner, said bladder having an open end and a sealed end;
 - c) impregnating said liner with a cold curable resin;
 - d) feeding said liner into the first end of the pipeline together with its associated bladder;
 - 10 e) inserting a rod into the bladder to engage the sealed end;
 - f) forcing said liner and the associated bladder toward the second end of the pipeline by pushing a rod into the pipeline from the first end such that the open end and the sealed end of the bladder are respectively disposed at or adjacent to the first and second end respectively;
 - 15 g) inflating said bladder from said open end with a gaseous fluid to force the liner against the internal wall of said pipeline; and
 - h) maintaining said inflation until the resin impregnated liner has cured.
2. A method for rehabilitating an existing pipeline in-situ, said pipeline having a first end and second end, said method including the following steps:
 - 20 a) forming a tubular liner of a generally absorbent material;
 - b) feeding at least one expandable bladder into said liner, said bladder having an open end and a sealed end;
 - c) impregnating said liner with a cold curable resin;

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- d) feeding said liner into the first end of the pipeline together with its associated bladder;
 - e) inserting a rod between the liner and the internal surface of the pipeline so as to engage a slit disposed adjacent an end of the liner;
 - 5 f) forcing said liner and the associated bladder toward the second end of the pipeline by pushing a rod into the pipeline from the first end such that the open end and the sealed end of the bladder are respectively disposed at or adjacent to the first and second end respectively;
 - g) inflating said bladder from said open end with a gaseous fluid to force the
10 liner against the internal wall of said pipeline; and
 - h) maintaining said inflation until the resin impregnated liner has cured.
3. A method for rehabilitating an existing pipeline in-situ according to claim 2 wherein the rod is engaged with the slit before the liner is fed into the pipeline.
4. A method for rehabilitating an existing pipeline in-situ according to claim 2
15 wherein, prior to being fed into the pipeline, the liner is folded longitudinally into halves and the rod is affixed to the liner by means of adhesive tape positioned so as to span the gap between the two halves of the liner.
5. A method for rehabilitating an existing pipeline in-situ according to claim 4 wherein, once the liner is fed into the pipeline by means of pushing the rod, the
20 bladder is inflated causing the folded liner to expand, thereby breaking or dislodging the adhesive tape so as to allow for withdrawal of the rod.

6. A method for rehabilitating an existing pipeline in-situ according to any one of the proceeding claims wherein said first end of the pipeline is generally accessible and said second end of the pipeline is generally inaccessible.
7. A method for rehabilitating an existing pipeline in-situ, said pipeline having a first end and a second end, said method including the following steps:
- a) forming a tubular liner of a generally absorbent material;
 - b) feeding at least one expandable bladder into said liner, said bladder having an open end and a sealed end;
 - c) impregnating said liner with a cold curable resin;
 - 10 d) threading a cord having a third end and a fourth end through said pipeline such that the fourth end extends from the second end of the pipeline;
 - e) attaching the third end of said cord to said liner and/or bladder;
 - f) drawing said fourth end through said second end for progressing said liner through the pipeline together with its associated bladder such that the open
 - 15 end and the sealed end of the bladder are respectively disposed at or adjacent to the first and second ends respectively;
 - g) inflating said bladder from said open end with a gaseous fluid to force the liner against the internal wall of said pipeline; and
 - h) maintaining said inflation until the resin impregnated liner has cured.
- 20 8. A method for rehabilitating an existing pipeline in-situ according to claim 7, wherein said cord is a rope or a cable.

9. A method for rehabilitating an existing pipeline in-situ, said pipeline including a main line to be rehabilitated and a secondary line branching from said main line, the method including the following steps:
- a) forming a tubular liner of a generally absorbent material;
 - 5 b) feeding at least one expandable bladder into said liner;
 - c) determining a junction position along the main line at which said secondary line branches from said main line;
 - d) cutting a hole in said liner at a position corresponding to the junction position;
 - 10 e) impregnating said liner with a cold curable resin;
 - f) feeding said liner into the pipeline together with its associated bladder such that said hole is aligned with said secondary line;
 - g) inflating said bladder with a gaseous fluid to force the liner against the internal wall of said pipeline; and
 - 15 h) maintaining said inflation until the resin impregnated liner has cured.
10. A method for rehabilitating an existing pipeline in-situ including the following steps:
- a) forming a tubular liner of a generally absorbent material;
 - b) feeding at least one expandable bladder into said liner;
 - 20 c) feeding at least one cable or conduit between said bladder and liner;
 - d) impregnating said liner with a cold curable resin;
 - e) feeding said liner into the pipeline together with its associated bladder;

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- f) inflating said bladder with a gaseous fluid to force the liner against the internal wall of said pipeline; and
 - g) maintaining said inflation until the resin impregnated liner has cured, thereby encasing said cable or conduit within said resin.
- 5 11. A method for rehabilitating an existing pipeline in-situ including the following steps:
- a) forming a tubular liner of a generally absorbent material;
 - b) feeding at least one expandable bladder into said liner;
 - c) impregnating said liner with a cold curable resin;
 - 10 d) coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating;
 - e) feeding said liner into the pipeline together with its associated bladder;
 - f) feeding at least one cable or conduit between said liner and said pipeline;
 - g) inflating said bladder with a gaseous fluid to force the liner against the
 - 15 internal wall of said pipeline; and
 - h) maintaining said inflation until the resin impregnated liner has cured.
12. A method for rehabilitating an existing pipeline in-situ according to claim 10 or 11 wherein said cable is an optical fibre telecommunications cable.
13. A method for rehabilitating an existing pipeline in-situ according to any one of
- 20 claim 10 to 12 and 15 wherein said cable or conduit is positioned along the length of the pipeline so as not to obstruct junctions branching from the mainline.

14. A method according to any one of claims 1, 2, 7, 9 or 11 including the step of coating an external surface of said liner and/or an internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating.
15. A method of rehabilitating an existing pipeline in-situ substantially as here
5 described with reference to any one of the accompanying drawings.

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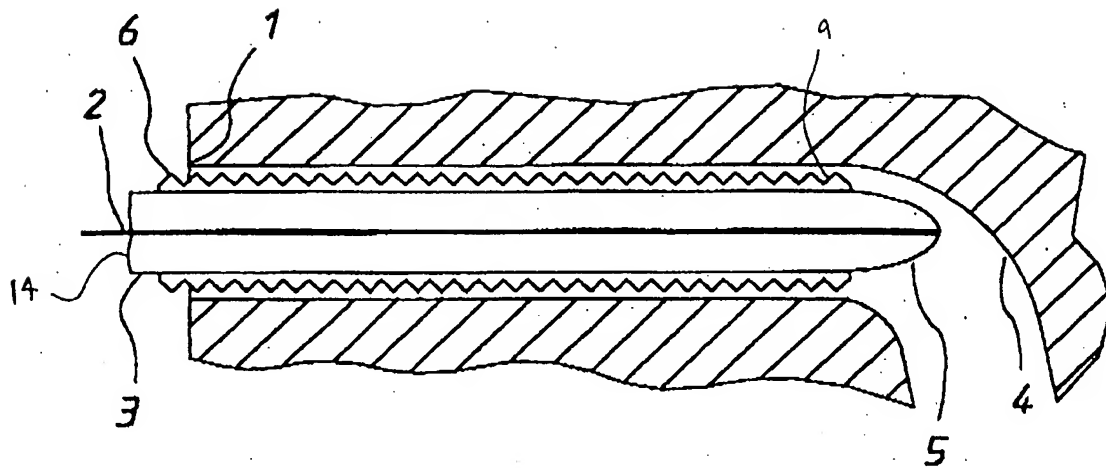


FIG. 1

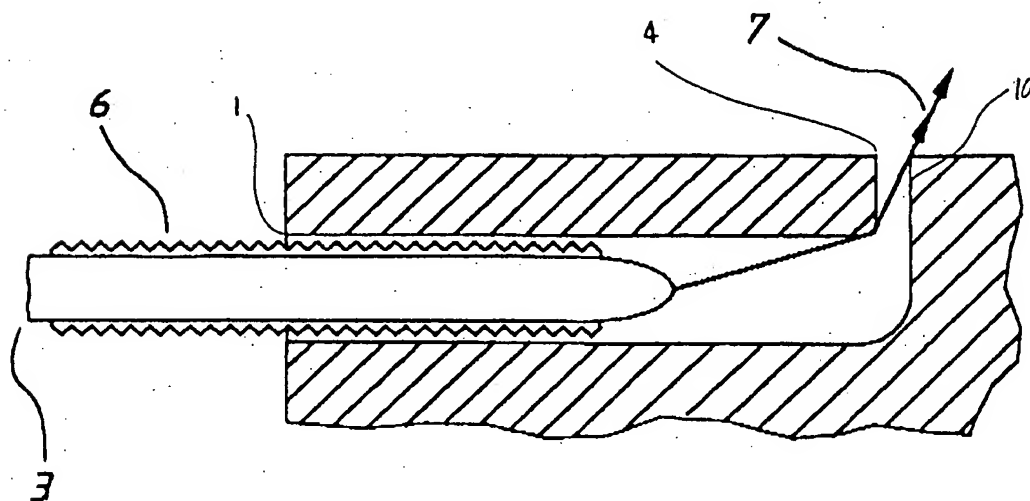


FIG. 2

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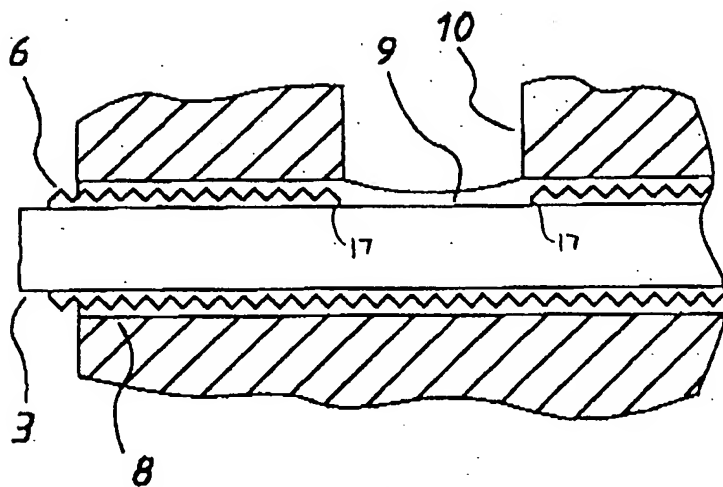


FIG. 3

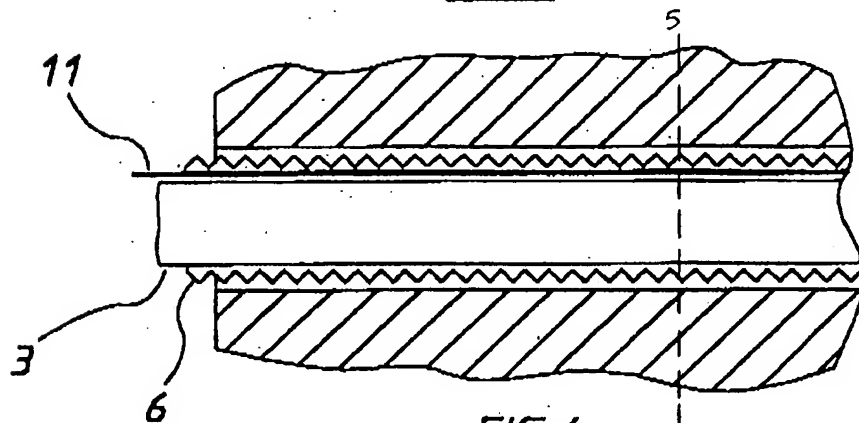


FIG. 4

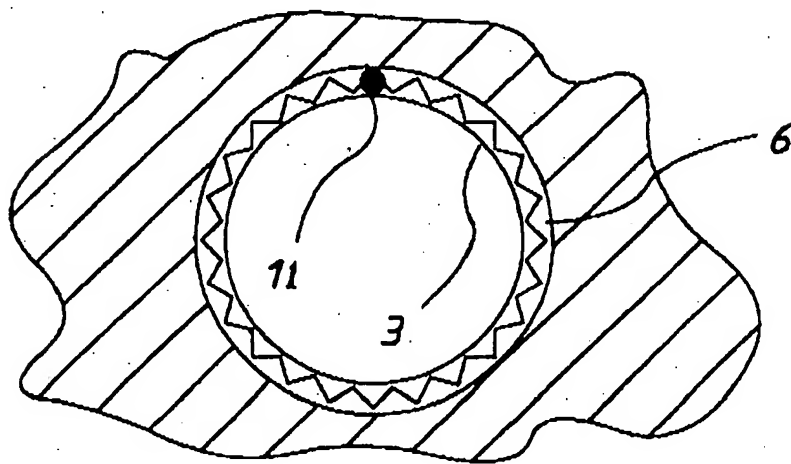


FIG. 5

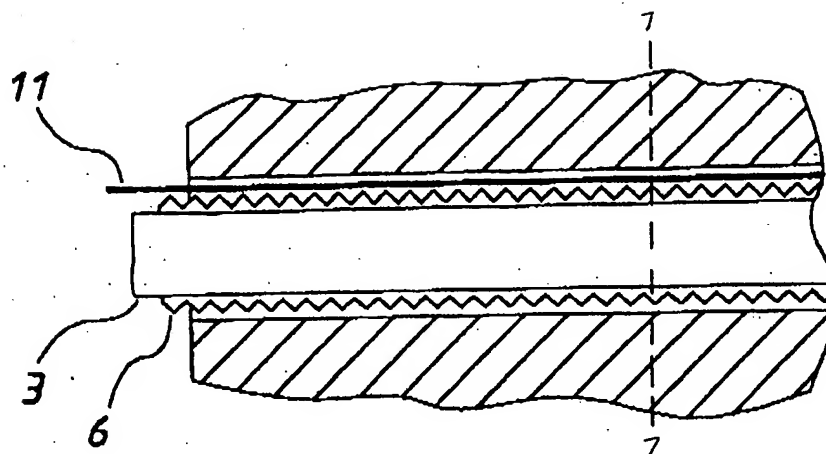


FIG. 6

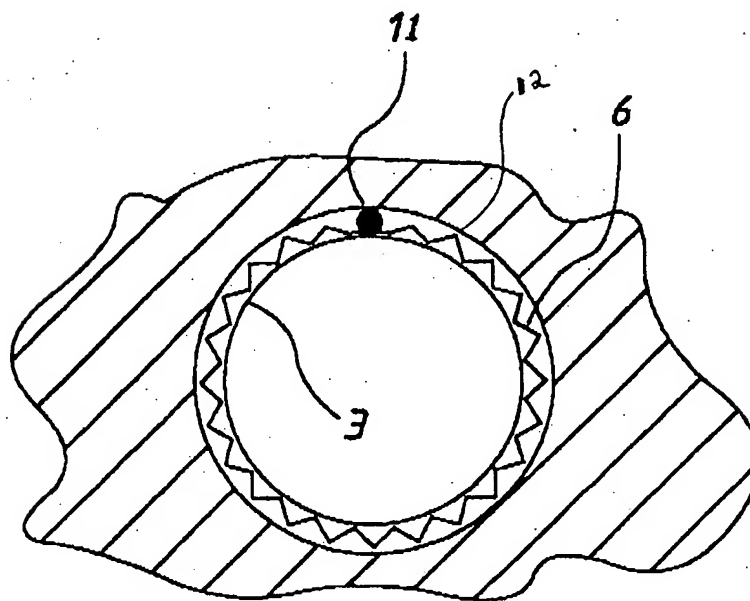


FIG. 7

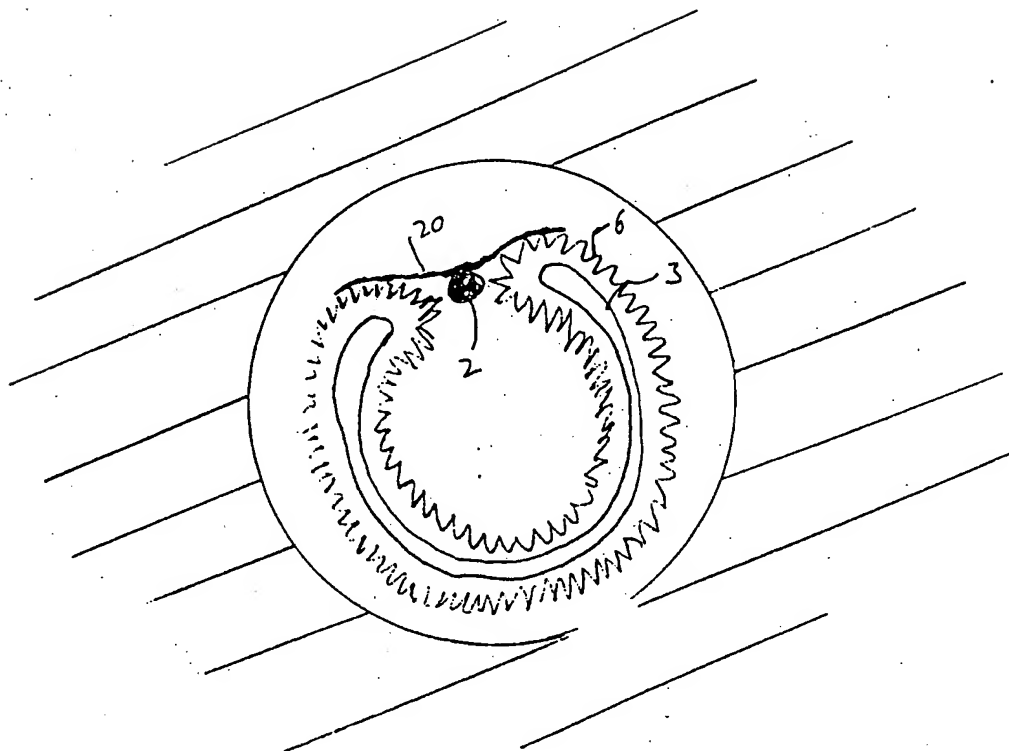


FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/AU 98/00388

A. CLASSIFICATION OF SUBJECT MATTER		
Int Cl ⁶ : F16L 55/162		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC: F16L 55/162		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU: IPC as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT: (resin(2) liner #) and (inflat; or expan: or pressuriz:) WPAT: (F16L, 55/16, 55/162 57/00, 58/10 or B29C 63/18, 63/20) and Liner:		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96/06300 A (LMK ENTERPRISES) 29 February 1996	9, 10
Y	See entire document	1-8, 11-15
Y	AU 16378/95 A,(CANT) 19 October 1995	1-15
Y	See entire document	
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
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Date of the actual completion of the international search 24 June 1998		Date of mailing of the international search report -6 JUL 1998
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929		Authorized officer R. WEBER Telephone No.: (02) 6283 2546

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